BULLETIN No. 3 MARCH, 1944

WATER EROSION OF SOILS IN THE PRAIRIE PROVINCES AND ITS CONTROL

Hordes of gullies now remind us
We should build our lands to stay;
And departing leave behind us
Fields that have not washed away.
Then when our boys assume the mortgage
On the land that's had our toil,
They'll not have to ask the question,
"Here's the farm, but where's the soil?"

—Anonymous.
With apologies to Longfellow.

LINE ELEVATORS FARM SERVICE
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FOREWORD

FIFTY thousand copies of "Water Erosion of Soils in the Prairie Provinces" (Bulletin No. 1) have been distributed, and the supply was exhausted over a year ago. The demand from farmers and schools has continued and we are responding with a new and enlarged bulletin on the same subject.

The Experimental Farms Branch of the Dominion Department of Agriculture has, in recent years, carried on extensive experimental work on erosion control. The Dominion Experimental Station, Swift Current, has played a prominent part in this programme, and we have been fortunate in securing the invaluable advice and assistance of Mr. L. B. Thomson and his staff in the preparation of this bulletin.

Bulletin No. 1 was designed to draw public attention to a problem the seriousness of which was not fully appreciated even by farmers. This publication goes much further in that greater emphasis is placed on control not only on cultivated lands, but on pastures and ranges as well.

The sponsors of the Line Elevators Farm Service are confident that this bulletin will serve a useful purpose, and hope that it may stimulate a wider interest in the extremely valuable findings of government experimental institutions, and the practical applications thereof.

S. D. MacEACHERN,

Chairman,

Line Elevators Farm Service Committee.

WATER EROSION OF SOILS IN THE PRAIRIE PROVINCES AND ITS CONTROL

K. W. NEATBY

"No state that regards its future can afford to shut its eyes to such a menace."

—(*W. D. Albright, Scientific Agriculture, Vol. 19, p. 242*)

INTRODUCTION

IT is estimated that, in the United States, wind and water erosion have ruined as productive land 50 million acres. This represents about one-sixth of the cultivated area. In addition, another 50 million acres have been more or less seriously damaged. Since many fields are affected by both wind and water erosion, it is difficult to assess the relative importance of these two soil destroying agencies. However, it is apparent from the results of surveys made by the United States Soil Conservation Service that water has caused much more damage than has wind.

In the Prairie Provinces of Canada, wind erosion, commonly called 'soil drifting', has unquestionably caused more damage than has water erosion. However, the soil drifting problem is fairly well in hand though by no means solved. Losses of soil and water resulting from 'run-off' are becoming more serious year by year, and are certainly not fully appreciated.

Canada is not the first nation to neglect or underestimate this problem. According to J. G. Lindley of the United States Soil Conservation Service, the French geographer, Elisee Reclus said, in 1873, that "among the causes which, in the history of mankind, have effected the extinction of so many forms of civilization we must place in the first order the reckless violence with which most nations have treated the soil which nourished them."

An American writer, Angus MacDonald, has this to say about the problem in Oklahoma: "Water erosion, in particular, escaped notice. The land was gradually whittled away; the changes, imperceptible at first, were discovered too late or ignored as unimportant. Even where erosion had reached a point where it could no longer be ignored, it did not receive the consideration that it merited." (Soil Conservation, April, 1937.)

Despite the fact that for many years far-seeing citizens of the United States, including George Washington himself, were aware that serious losses were being suffered; it was not until 1935 that, in the words of Dr. H. H. Bennett, "Congress for the first time recognized accelerated erosion as a national menace and declared it to be the policy of Congress 'to provide permanently for the control and prevention of soil erosion and thereby to preserve natural resources.' "

Many centuries ago, before our present vegetative cover became established in the Prairie Provinces, erosion must have been very rapid. Evidence of this is provided by the immense valleys and coulees which wind their way through prairie and woodland. However, the establishment of grass and forest covers led to an approximate balance between soil loss and soil formation. It is apparent, therefore, that present day problems of erosion are primarily due to the destruction of native vegetation. **Our problem is to find some means of cultivating the soil and, at the same time, of preserving it.**

CAUSE OF WATER EROSION AND FACTORS WHICH AFFECT ITS RATE

THE cause of water erosion is, obviously, running water. Just as air currents carry off soil, so do water currents. Both agencies cause a sort of 'sifting out' of soil particles. The large particles (stone, gravel and coarse sand) are moved very short distances, or not at all; the fine sand and silt are deposited after relatively short journeys, while the finest particles may be carried for great distances. Thus the most valuable fractions, consisting of clay particles and organic matter, or humus, are those most easily lost.

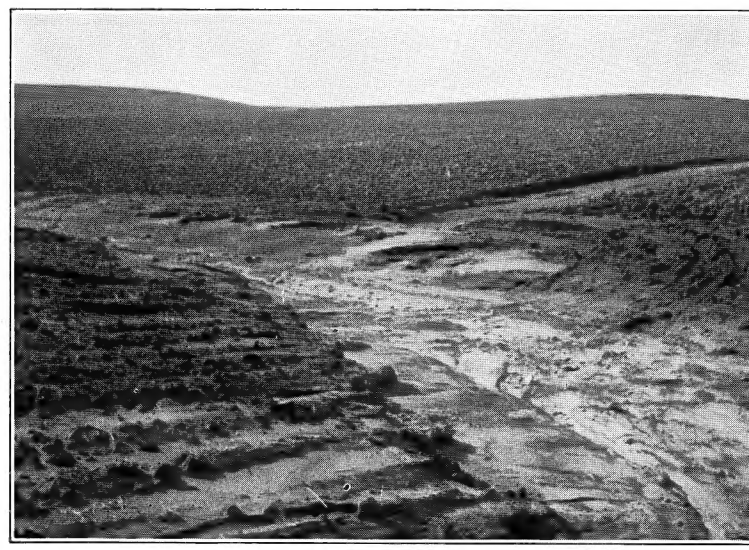

FIGURE 1. Walsh, Alberta. This shows erosion caused in the bottom of a large draw. The greater portion of the water coming down the draw did not originate on this field. The small tributary gully (upper right) drains only a small area. Note the sheet erosion and evidence of silting in the lower left hand corner.

—(Courtesy of Dominion Experimental Station, Swift Current.)

Water erosion occurs in two forms, namely; sheet erosion and gully erosion. Sheet erosion is less obvious but often more damaging than gully erosion. It entails the loss of soil, in layers more or less uniformly thick, from the entire area affected. This con-

dition is apparent in Figures 1, 3, 4, 5, 6, 8, 13, 14 and on the front cover of this bulletin. Rills and small gullies are also apparent. Typical examples of gully erosion are illustrated in Figures 1, 2, 3, 4, 8, 11 and 15. When gully erosion is observed, sheet erosion is usually also taking its toll. Sheet erosion is usually soon followed by small rills which converge to form gulleys which, if unchecked, may grow to the proportions illustrated in Figure 3.

The rate or severity of water erosion is affected by many factors associated with properties of the soil, topography, climate, cultural practices, etc. Only a few of the more important can be given consideration here.

THE PHYSICAL PROPERTIES OF THE SOIL

Physical characteristics have an important bearing on susceptibility to erosion. Soils which readily become dispersed or suspended in water are more susceptible than those which do not. The readiness with which soils disperse is, of course, related to the size of individual particles; but also to what is known as soil 'structure', a term which concerns the tendency of soil particles to adhere together in clusters or 'aggregates'. Soils are said to have a desirable structure when the particles are well aggregated. Likewise, the presence of granules and clods of larger dimensions is indicative of good 'tilth'. The reason for this is to be found in the fact that aggregation is related to porosity, and porous soils tend to absorb water readily. On the other hand, soils characterized by poor structure tend to 'puddle' and to resist penetration by rain. Their behaviour is somewhat similar to that of ordinary bread flour which, upon being wetted, becomes sealed and almost impervious to water. When soils behave in this manner, loss of both water and soil is inevitable.

The question of soil structure may seem to be of scientific rather than of practical interest; but such is not the case, since cropping practices have an important bearing on the physical

properties of the soil. For example, experiments conducted at the Soil Conservation Experimental Station at Clarinda, Iowa, have demonstrated that applications of organic matter to the surface layers of soil in the form of barnyard manure or green manure (sweet clover) had a pronounced effect on soil porosity. This was reflected in decreased run-off and an increase in available soil moisture.

CLIMATIC FACTORS

Climatic factors have both direct and indirect effects on water erosion. As an example of a direct effect we may point to the fact that frost protects our Prairie Province soils from water erosion for some five or six months in the year. In the Southern States, however, winter protection is an important consideration in field practice. The seasonal distribution of rainfall and the frequency of heavy downpours are other important direct factors.

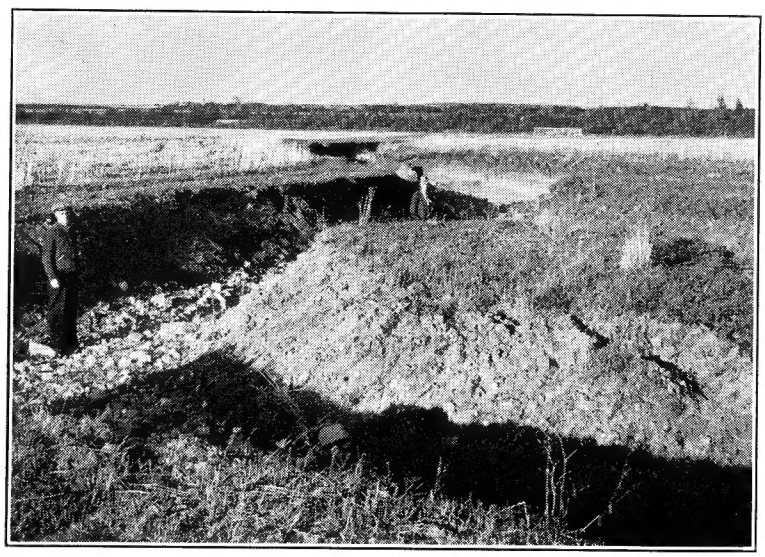

FIGURE 2. Six-foot gully, with tributaries, cut through what had been a nice smooth field of black soil southwest of Halcourt, Alberta. The havoc dates practically from the summer flood of 1935. Photographed May, 1938.

—(Courtesy of Dominion Experimental Station, Beaverlodge.)

Relatively enormous amounts of rain may cause little or no erosion if they are well distributed throughout the year; but two inches of rain in one hour where the annual precipitation is only twenty inches may constitute a great peril. Rainfall will penetrate very dry soil only with difficulty. Thus a heavy downpour is likely to be more damaging after protracted drought than if the soil is moderately moist. Indirectly, climate affects erosion through its influence on the natural processes of soil formation.

TOPOGRAPHY

The extent to which land is sloping or rolling has a bearing which is obvious. We need not worry much about water erosion in the Red River Valley or on the Regina Plains. It is not always possible to define the degree of slope which is safe, because there are many other factors, such as soil type, rainfall, vegetation, etc., that influence the amount of run-off and soil carried away. Where there is a steep slope, erosion of some kind will occur sooner or later. It is estimated that 75 percent of the cultivated land in the United States is sufficiently sloping to be subject to erosion, unless measures are taken to prevent it. While no figures are available in Canada, it is probable that approximately the same condition prevails.

CULTURAL PRACTICES

Management of the land may make or break the soil. In discussing the problem of water erosion in the grain growing areas of the Pacific Northwest, E. M. Rowalt, writes: "Of all farming practices that contribute to loss of soil from cultivated fields in the Northwest, the clean summerfallow is plainly the principal offender."

Since we must return to the question of cultural practices when control measures are considered, further discussion at this time is unnecessary.

LOSSES DUE TO WATER EROSION

THE illustrations in this bulletin supply about all that is necessary to a section on losses. However, there are those who believe that subsoil is quite as productive as surface soil, and the following remarks are addressed to them.

It is true that there are some very deep fertile soils. An outstanding example is that of the Regina Plains where, possibly, considerable quantities of surface soil might be blown or washed away without any immediate effect on crop yields. In areas of rolling land, however, the fertile surface soil is relatively thin on the uplands and the removal of five or six inches of soil by erosion will seriously affect the productivity of the land for some time. A field in central Saskatchewan which has already nearly reached this stage is illustrated on the front cover of this bulletin.

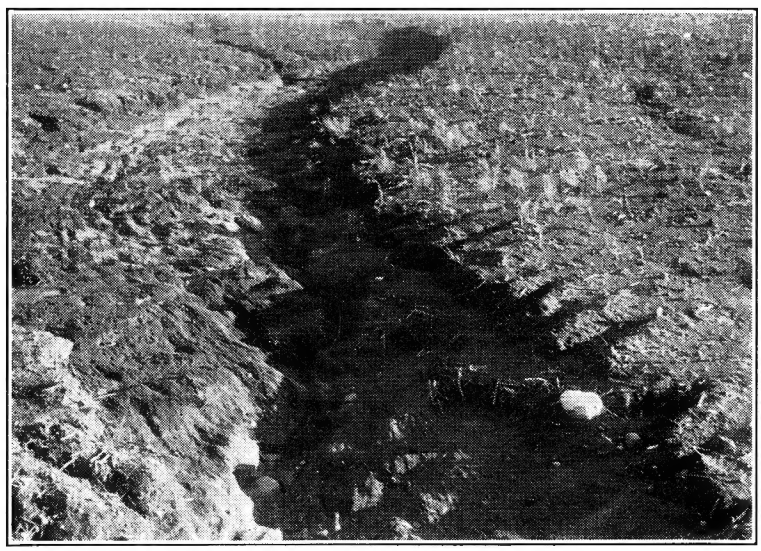

FIGURE 3. Many tons of fertile soil followed this route and are permanently lost. This is typical of summerfallowed fields observed in parts of central Saskatchewan in July, 1940.

Any considerable amount of running water on bare summerfallow will cause damage to the land. While this is the most important phase of the problem, it is well to remember that, at the same time, the drought problem is being aggravated. In the Prairie Provinces, running water on cultivated fields is leaving the place where it is most needed, and moving to low lying ground where moisture conditions are more likely to be good. Therefore, if rainfall cannot be stored in summerfallowed fields **where it falls** losses of soil will occur and one of the chief objects of summerfallowing, which is to conserve moisture, will be defeated.

As an example of the effect on crop yields which may result if erosion is not checked, results of an experiment conducted in Minneasota by the United States Soil Conservation Service may well be quoted.

	YIELD, BUSHELS PER ACRE	
CONDITION OF SOIL	OATS	BARLEY
Less than 25% of topsoil lost	51	47
25% to 50% of topsoil lost	42	28
50% to 75% of topsoil lost	35	23
Over 75% of topsoil lost	25	17

Many other experiments have yielded results essentially similar, and let us not forget that for all practical purposes **the topsoil is irreplaceable.**

Other losses due to water erosion of agricultural land are serious in many parts of this continent. Expensive water reservoirs become filled with silt, fertile lowlands are often ruined by deposits of silt and debris, road embankments are washed away, dangerous gullies are cut in road ditches, river floods are aggravated, and so on.

CONTROL MEASURES

A discussion of controlling soil erosion in a publication such as this must necessarily be brief and general, because the details of control depend almost entirely upon local conditions in the district and even on the individual farm concerned. One of two purposes must be achieved. Either the rain must be absorbed where it falls, and snow where it thaws, or, if this is impossible, excess water which runs off must be prevented from carrying soil with it. If rain is made to run away slowly, little or no soil is lost.

FIGURE 4. Representative of the damage being done on the northern slopes of the Turtle Mountains in southwestern Manitoba.

—(Courtesy of Dominion Experimental Farm, Brandon.)

Wherever possible, excessive run-off should be prevented. Its control can be achieved in the Prairie Provinces except, possibly, when heavy downpours of rain occur on steeply sloping land, and when there is a rapid run-off during the spring freshet.

TILLAGE METHODS ON CULTIVATED LAND

Methods that may be followed in preventing soil erosion could include one or more of the following:

1. Using only those tillage practices which tend to keep the stubble and trash anchored at the surface of the soil. This practice not only retards the flow of the water, but leaves the land in a condition to absorb it more readily.

2. When working sloping land, tillage practices such as one-waying, cultivating, plowing, etc., should follow the contour of the land as much as possible. If the work is done in the same direction as the slope, gullying will soon occur.

3. On rolling land that is cultivated, it is advisable to select the most steeply sloping areas, where erosion usually starts, and seed them permanently to grass. The yield in grain crops is usually low from these areas, and they are a source of continual trouble.

4. In more humid areas, seeding a grass crop in the rotation minimizes the damage from water erosion, and may be absolutely essential on hilly land.

Many tillage implements leave the land more or less ridged. Indeed, deliberate ridging is an important aspect of soil drifting control. The use of implements, such as the duck-foot cultivator, up and down the slopes of rolling land often seriously increases the extent of water erosion (See Figures 5 and 6). As a result, operating tillage machinery on the contour instead of straight up

and down the fields has become a common practice in soil erosion control. Contour tillage retards run-off by forming a continuous series of ridges at right angles to the slope. On relatively broad sweeping slopes, the inconvenience of contour tillage is at least partly offset by a saving in fuel consumption. Unfortunately, much of the rolling land in the Prairie Provinces consists of relatively small knolls, depressions and sloughs or 'pot holes'. On land of this kind contour tillage is impossible or, at least, impracticable.

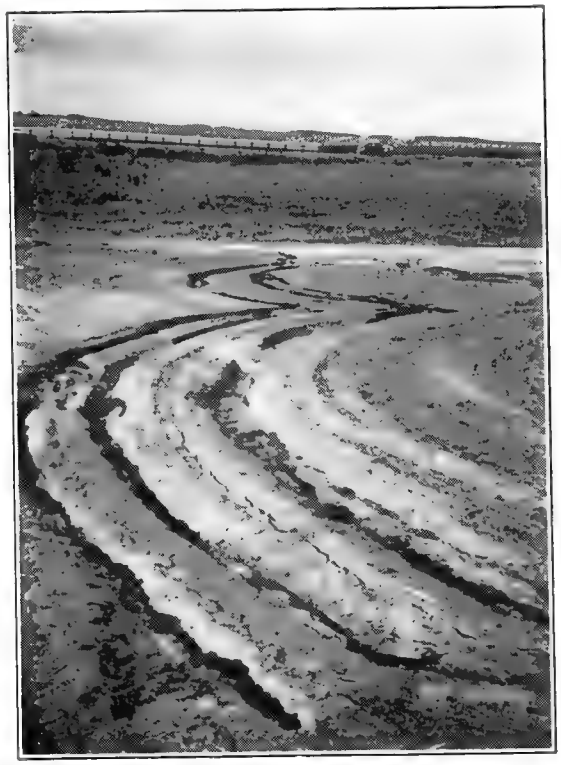

FIGURE 5. Rill erosion down tracks of a duck-foot cultivator. Photograph taken in July, 1940, near Yorkton, Saskatchewan.

—(Courtesy of Professor John Mitchell.)

CROP ROTATIONS

The problems of preventing erosion and maintaining soil fertility are many and varied. Whether the system of growing one or more grain crops after fallow can be maintained indefinitely remains to be seen. Certainly, the introduction and widespread adoption of the combine method of harvesting, which leaves all the straw on the land, has altered the picture.

In the drier parts of the open plains, very little cultivation is required to keep weed growth in check. If the straw and trash grown on the land are retained on the surface of the soil by careful cultural practices, it should be possible to prevent erosion and maintain the fertility of the soil for many years. Too frequently, however, heavy stands of stubble are burnt off so as to facilitate working the land. A continuation of this bad practice merely hastens the time when some drastic measures will become necessary to restore fertility and fibre to the soil, if serious depletion and erosion problems are to be avoided.

FIGURE 6. This field had been single-disced. The middle of a disc track provides an ideal channel for water to run off the field. July, 1940, in the Theodore-Springside district in Saskatchewan.

In the park belt and wooded areas of the three Prairie Provinces there are no serious technical difficulties involved in growing grasses, legumes or grass-legume mixtures. Weed control is essential, and with more intensive cultivation it is difficult to maintain a trash cover. Consequently, growing grasses or legumes in a rotation will minimize the erosion problem. The wider adoption of mixed farming will tend to correct a number of soil problems, particularly water erosion.

FIGURE 7. Surface worked fallow at the Shaunavon Sub-station, August, 1941. All the stubble has been maintained on the surface of the soil by using a blade weeder.

—(Courtesy of Dominion Experimental Station, Swift Current.)

CONTOUR STRIP CROPPING

Just as strip farming, in conjunction with appropriate tillage methods, has played a leading role in the control of soil drifting on the western plains of Canada and the United States, so has contour strip cropping been adopted in many parts of the United States in the water erosion control programme. This practice involves the alternation of strips of erosion susceptible crops such as cotton or tobacco with erosion resistant crops such as grasses and clovers. Since the strips are planted on the contour, the retarding effect on run-off is obvious. The width of the strips is determined by local conditions including degree of slope, frequency of heavy downpours, soil type, crops grown, etc. This method of controlling erosion is not applicable in the Prairie Provinces except where slopes are large and broad. In most of our rolling land, contour strip cropping would involve too many short turns and adjustments of strip widths to be practicable.

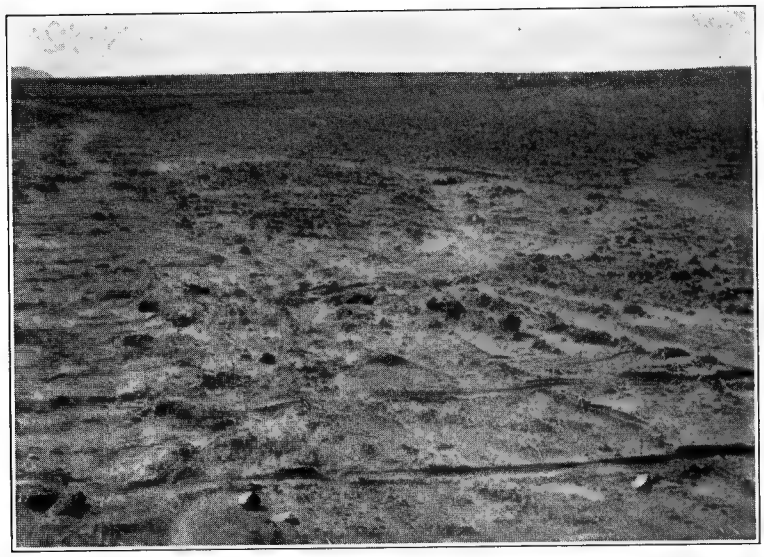

FIGURE 8. Walsh, Alberta. A gully tributary to the main draw. The watershed of this gully is all on this field. The soil has been removed to the plow sole. Note the extensive sheet erosion on the slopes away from the gully.

—(Courtesy of Dominion Experimental Station, Swift Current.)

TERRACING

The broad-base terrace may be used in certain areas, but is not practical in extremely rolling or rough land on account of the high cost of construction per acre. The terrace is made on the

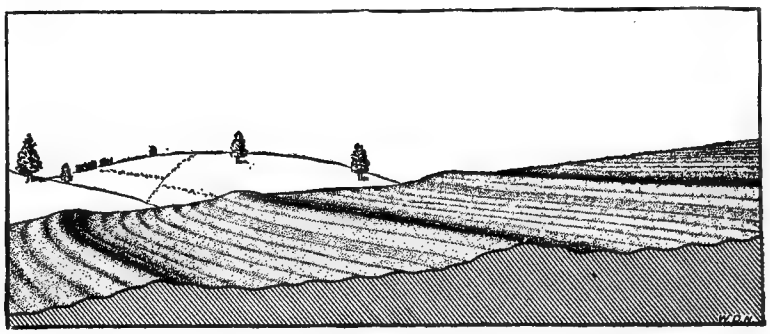

FIGURE 9. Diagram illustrating the use of modern terraces as commonly constructed on cultivated hillsides.

—(Courtesy of McGraw-Hill Book Company, Inc.)

contour with a small grade and a broad-base channel. The run-off water is collected and slowly flows down the broad basin. The outlet at the end should be broad, and the water should be guided into a grassed runway to prevent gullying from concentration of the stream. The terraces can be built on cultivated lands so it is possible to work over them with ordinary farm implements.

FIGURE 10. Terrace banks being cut away as a result of ice formation in the broad-base channel.

—(Courtesy of Dominion Experimental Farm, Brandon.)

A rather serious problem has been encountered in connection with terraces at the Dominion Water Erosion Control Station, Boissevain, Manitoba. In many springs, early thaws fill the terrace channels with water which later freezes. During subsequent thaws there is sometimes much run-off before the ice in the terrace channels can melt, with the result that terrace sides are cut away as illustrated in Figure 10. This problem, at present, remains unsolved.

In establishing terraces on any farm, it is advisable to obtain engineering assistance.

RESEEDING CONTROL MEASURES

In ranching areas the cheapest method of control is by restoring the plant cover. This may, also, be an appropriate measure on cultivated land (Figure 11). An adequate cover of deeply and extensively rooting grasses is the best means of maintaining the soil in a physical condition to resist erosion. Roots and decaying organic matter make the soil porous allowing the surface water to get away into the subsoil, acting in a manner similar to that of blotting paper.

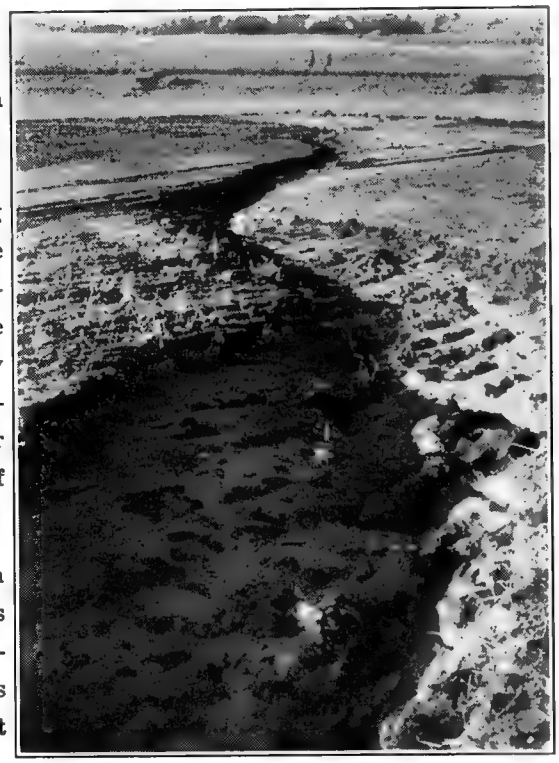

FIGURE 11. The field in the foreground is summerfallow, and the one in the background is a mixture of brome grass and alfalfa sown with a nurse crop in 1939. There was no sign of erosion in the hay field though the slopes were in general quite as steep as those on the fallow. Photographed in July, 1940, in the Theodore-Springside district in Saskatchewan.

The aim of erosion control measures is to establish sufficiently heavy stands of erosion-resistant vegetation as quickly as possible. Under conditions prevailing in the Prairie Provinces this can best be achieved by establishing thick stands of extensively rooted, drought resistant grasses such as crested wheat grass. Other grasses which may be used are brome, western wheat grass, slender wheat grass and blue grama. The latter forms dense mats of vegetation

on the surface of the soil. Unfortunately, the seed of this grass is difficult to obtain and stands take some time to become established. In some cases, mixtures of grasses, such as crested wheat grass and brome or a grass and a legume, such as sweet clover or alfalfa, may be used to advantage.

Water erosion is particularly apparent during the spring run-off and in the summer when heavy downpours of rain occur. Since young grass seedlings are easily washed away, careful planning of seeding operations is essential. At Swift Current, and elsewhere, experience indicates that it is wise to sow a cover crop of an annual, such as wheat or oats, and to sow crested wheat grass or brome grass at the same time or later, possibly about the 20th of August. It is, however, impossible to lay down hard and fast rules. Mr. M. J. Tinline, referring to conditions in south-western Manitoba, writes as follows: "Seldom will grasses sown on August 20th become sufficiently established to resist water erosion from the run-off the following spring. We believe it will take a full season's growth for the grass to become sufficiently established so that it will offer material resistance to erosion." Livestock should be kept off the newly sown areas and, as a rule, fencing will be necessary. Thus, when cover crops are employed, the aftermath will protect the surface of the soil the following spring and allow the grass to become firmly established. However, complete stabilization of the soil should not be expected too quickly for in many cases the permeability and salt content of the subsoil have much to do with the rate at which the new vegetation becomes established.

Mr. W. D. Albright, Superintendent, Dominion Experimental Station, Beaverlodge, has very kindly commented on the above references to crested wheat grass and on the use of nurse crops. He writes as follows: "Our experience is that in the park belt brome is better, and a timothy component is advantageous because of the quick establishment of this grass." With reference to the use of nurse crops he advises:—". . . I doubt whether it would be very successful here. I recall a nurse crop seeding of brome which I acquired some years ago. The stand established itself thinly and slowly. Ditches cutting through got below the roots, after which the sod was useless. We incline to favour non-nurse-crop seeding done earlier in the season but are not positive on this point."

The above discussion serves to emphasize the importance of studying local conditions and experiences very carefully before embarking on an erosion control program. The experiences of other farmers in the district and the advice of Dominion and Provincial Government agricultural experts should be exploited before the work is done rather than afterwards.

A number of other plants, such as Kudzu, have been used for erosion control in the United States, but most of these are not hardy enough for conditions prevailing in the Prairie Provinces.

GULLY EROSION AND ITS CONTROL

Gully erosion is very noticeable, even to the uninitiated. The most effective and cheapest way to control it is by seeding the gully with a grass mixture as outlined in the previous sections. During the period that the grass is being established, the run-off water should be kept out of the gully either by means of temporary dikes or dams above the gully or by diverting it through a ditch. In most cases, it is advisable to obtain the advice and assistance of an agricultural engineer.

FIGURE 12. A completed soil saving dam in operation at the Dominion Experimental Station, Swift Current, during one of the May rains. Very little damage resulted at this point, the dam working satisfactorily.

—(Courtesy of Dominion Experimental Station, Swift Current.)

There are many types of gullies and of control measures. The following remarks are concerned with conditions frequently encountered:

1. The occurrence of erosion in coulees on grazing land or in cultivated fields eventually causing deep gorges. One measure for control is the use of a soil saving dam in the gully bottom as shown in Figure 12. Good control has been obtained by this plan in gullies with small run-off and minimum grades.

2. Where a gully serves a large drainage area on cultivated or grazing land, and where there is a drop into a flat or a natural grassed runway, it is possible to develop a good water control plan. First, a suitable site for a dam could be located, and then contour dykes constructed on gentle grades. This plan would prevent erosion on the upper land and then the run-off water would be diverted around the contour dykes and would flood irrigate the lower land improving the moisture supply.

3. In situations where the above plans will not serve, the following measures are suggested:

   (a) The broad-base terrace on gentle grades.

   (b) A diversion ditch which after grassing is used to by-pass the eroding gully.

   (c) Contour furrows, i.e., simply furrows or small ridges on the contour.

In a letter to the author, Dr. John Mitchell, University of Saskatchewan, writes as follows: "I might mention that in advising farmers re gully erosion, we generally suggest that they check the source of the flow of water. This quite frequently traces to a badly placed culvert or unfortunately placed and constructed road ditch. However, sometimes the trouble is due to a careless farmer with land on a higher part of the slope. In grassing down gullies, we usually advise sloping in the sides so they can be crossed with implements. In seeding the gully to grass, it might be advisable to plant a quick-growing cover crop towards the end of the season and later seed to grass. Spreading straw or manure is, of course, a helpful practice and in some cases perhaps one should advise the use of small check dams. One thing appears fairly certain, and that is that once the gully appears, unless the water can be almost completely diverted, then grassing is absolutely essential."

WATER EROSION ON PASTURE LAND

THE extent of water erosion on pasture and grazing lands is not fully realized. Casual observations readily reveal the fact that the seeds of future severe soil erosion are already widely distributed, and that immediate action is necessary to cope adequately with the situation and to correct the conditions which will inevitably lead to the destruction of extensive grazing areas. Closer inspection of the range lands further emphasizes the wide distribution, extent and possible seriousness of erosion damage.

Up to the present time soil erosion on range lands has been of the gully type rather than of the sheet type, although restricted areas of sheet erosion are to be found throughout the area.

Many examples of gully erosion are found to have their origin in cattle and vehicle trails, which have become drainage channels for spring run-off water or heavy summer rains. Too often these increase in extent with incredible rapidity from year to year.

FIGURE 13. Over-grazed land in the Waterton Park, Alberta, area. A certain amount of sheet erosion has already taken place and gullying has started in the wagon trail.

—(Courtesy of Dominion Experimental Station, Swift Current.)

FIGURE 14. An area of severely over-grazed land in the Tilley East, Alberta, area. Considerable sheet erosion has already taken place on the hills.
—(Courtesy of Dominion Experimental Station, Swift Current.)

Cases of soil erosion induced by over-grazing are known on the Canadian prairies, but in general they are not extensive. The initial stages of such damage are often brought about by the loosening of the soil by the hoofs of livestock during dry periods. Subsequent wind erosion, which removes the soil from the roots of the vegetation, leaves the denuded area susceptible to sheet water erosion.

RANGE MANAGEMENT AS A CONTROL MEASURE

Sheet erosion of range lands in the Prairie Provinces is, as yet, restricted in area, but considerable damage is threatened. Periods of high prices for livestock tend to increase the danger in this direction by encouraging the over-stocking of ranges.

The following control measures should be practiced if range lands show signs of depletion:

1. Reduction in numbers of livestock carried.
2. Prevention of close grazing by livestock.
3. Good distribution of stock over the range by fencing, development of watering places and salting in little used areas. Salting places should be changed from time to time to prevent severe damage from tramping and to attract livestock into other parts of the range.

FIGURE 15. Effect of tramping and subsequent erosion in the Cochrane, Alberta, area. Immediate steps are necessary in such cases to prevent possible severe gully formation.

—(Courtesy of Dominion Experimental Station, Swift Current.)

GENERAL DISCUSSION

THERE is no doubt that soil erosion by water is an increasing menace in Western Canada. In some cases, the correction of the problem is beyond the individual farmer on account of the lack of equipment; but in others, it is not. Definite interest is being taken in this matter, but there is still a lot of planning to be done on both cultivated and grazing lands.

It would appear that soil erosion control, in a broad sense, must be regarded as a municipal or governmental problem, because in the majority of cases more than one individual is affected. Dirt moving equipment is purchased by municipalities for road work, etc. With a proper choice of equipment, there is no reason why it cannot be used for soil erosion work as well as for road work. The two really go together, because frequently soil erosion originates from improper planning in road building. Likewise in provincial highway construction all engineers should be con-

scious of the soil erosion menace, so that in future road building and maintenance, the problem is not aggravated.

It is quite true that there is a scarcity of trained men to advise farmers on soil erosion control because most of the agricultural engineers, who pioneered this work in Western Canada, are in the armed forces. Their experience in mechanization, however, will be a highly valuable one for the future, and these men should be a great asset to Western agriculture in the post-war period. In the meantime, however, it is to be hoped that every farmer will become more conscious of the erosion problem and undertake whatever control measures are possible, looking forward to more extensive cooperation with engineers, agronomists and municipal officials in the not too distant future.

ACKNOWLEDGEMENTS

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